COAL-MINE FIRES AND GAS AND/OR DUST IGNITIONS SINCE ENACTMENT OF THE 1952 FEDERAL COAL MINE SAFETY ACT

By C. M. Keenan

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COAL-MINE FIRES AND GAS AND/OR DUST IGNITIONS SINCE ENACTMENT OF THE 1952 FEDERAL COAL MINE SAFETY ACT[1/]

by

C. M. Keenan[2/]

SUMMARY AND INTRODUCTION

During the 7-1/2 years (January 1945-June 1952), immediately preceding enactment of the Federal Coal Mine Safety Act, 26 major disasters[3/] in the coal mines of the United States caused the deaths of 491 persons. In the next 7-1/2 years under the act (July 1952-December 1959), only 12 major disasters occurred. The total killed was 148. This improvement is commendable. However, the continuing frequency of minor fires and gas and/or dust ignitions in the Nation's coal mines, many of which could have been of major consequence, are cause for serious concern to the coal-mining industry and those affiliated agencies engaged in promoting safety in the industry.

The data presented in this report have been prepared to make available to the coal-mining industry and related groups an overall perspective of the disaster potential from mine fires and gas and/or dust ignitions in coal mines after 7-1/2 years under the Federal Coal Mine Safety Act. This act, effective July 16, 1952, which amended the original Federal coal-mine investigative act of May 1941, provides under Title II certain enforcible mine-safety provisions designed to prevent major disasters caused by explosions, fires, inundations, and man-trip and man-hoist accidents in coal mines that employ 15 or more individuals underground.

MINE FIRES AND IGNITIONS

In the first 4-1/2 years after the effective date of the Federal Coal Mine Safety Act (through 1956), only two major disasters, both explosions that caused 21 deaths, occurred in the coal mines of the Nation. In 1957, after 26 disaster-free months, there were five major disasters, of which four were explosions that caused 59 deaths. Three major disasters, including two explosions that killed 36 men, occurred in 1958. An explosion resulting in 9 fatalities and an inundation resulting in 12 fatalities occurred in 1959. This

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1/ Work on manuscript completed February 1960.

2/ Technical assistant, Division of Coal Mine Inspection, Bureau of Mines, Washington, D. C.

3/ The Federal Bureau of Mines classifies as a major disaster any accident in which 5 or more lives are lost.

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record of 12 major disasters in less than 7 years (10 in a recent 27-month period) is cause for serious concern, if not alarm, to those affiliated with the coal-mining industry. (See table 1.)

Administration of the Federal Coal Mine Safety Act has assisted materially in reducing the probability of widespread major disasters in coal mines. Nevertheless, the frequency of mine disasters and minor mine fires and gas and dust ignitions indicates that much must be done before serious catastrophes can be prevented.

From the effective date of the act (July 1952) through 1959, a period of 7-1/2 years, the Bureau of Mines investigated 204 gas and/or dust ignitions that caused 165 fatal and 235 nonfatal injuries (see tables 2, 3, 4, and 5) and 355 underground mine fires that caused 12 fatal and 71 nonfatal injuries (see tables 6, 7, and 8). One hundred and sixty seven of the ignitions and 319 of the fires were in mines employing 15 or more men underground (covered unter Title II of the act). The ignitions include 2 of gasoline that seeped into the mines from surface pipelines, 1 of acetylene, and 10 of coal dust in which no gas was involved. The foregoing covers only those occurrences of which the Bureau had notice, but there undoubtedly were other minor ignitions and fires of which the Bureau was not advised.

A breakdown of the 204 ignitions by primary sources shows that 72 (35 percent) were initiated by electricity, 37 by explosives, 38 by sparks from cutting bits, 35 by open flame or smoking, 8 by flame safety lamps, 4 by mine fires, and 1 by lightning; in 9 ignitions the source could not be determined definitely.

A further breakdown of electrical ignitions, the greatest offender, reveals that 28 were caused by locomotive trolleys or nips, 19 by face equipment or fans, 8 by trailing cables, 11 by electric arcs due to lack of frame grounding, 3 by feeder cables, 1 by an electric switch, 1 by a pump, and 1 by an electric-light bulb.

Two hundred and twenty four (63 percent) of the 355 underground mine fires investigated were caused by electricity. Of these, 103 were started by overheated trailing cables or poor trailing-cable splices, and 37 were belt-conveyor fires. (See table 8 for further details).

Fortunately, none of the mine fires was a major disaster, but those who have combatted mine fires know well that each one has disaster potentialities, especially in gassy mines. Investigations of these fires and ignitions have indicated that injuries and extensive property damage frequently were held to a minimum, because alternate escapeways and fire-fighting equipment were available, as well as men trained to use the equipment, and reasonably good rock dusting in the areas where the ignitions occurred. However, many other fires were not serious due only to good fortune.

Generally, ventilation, rock dusting, fire prevention, alternate escapeways, and other preventive measures to minimize or cope with disaster hazards in coal mines are better today than they ever were. Such favorable factors

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materially reduce the probability of major catastrophes. Nevertheless, the continuing frequency of these minor fires and gas and dust ignitions presages future trouble, unless additional efforts are made to obtain full-time compliance with accepted preventive measures.

It is recognized that inadequate ventilation is the primary cause of gas ignitions. A factor of almost equal importance is the prevalence of sources of ignition. On the basis of the foregoing data, these ignitions are mainly caused by poor installation and maintenance of electrical circuits and equipment. Poorly made temporary splices in trailing cables, inadequate overload protection, and runover cables are all too common. Failure to make proper, suitable tests for gas where electrical equipment is operated has been another important contributor to these ignitions.

Technical surveys by Bureau electrical engineers have revealed that too few of our coal mines have adequate overload protection against short circuits in remote areas of the mine. Some mines have virtually no protection at all, although they have installed circuit breakers and fuses that are supposed to provide it.

This lack of protection is due to inadequate current-carrying capacity of the conductors, caused by cables in insufficient cross-sectional area, poor or too many splices, and improper rail bonding, also to length of circuits. These defects build up the resistance to a point where a dead short circuit could occur at any place inby a certain distance from the circuit breaker, and insufficient current would flow to trip the protective device; this is not uncommon.

The proper procedure in overcoming these hazardous conditions is to make a periodic technical survey of all electrical circuits. When high resistance is indicated, it should be corrected. Other readily observed signs forewarn of danger. For example, low voltage in working areas may point to inadequate power circuits. Overheating of cables, sluggish operation of equipment, and excessive dimming of lights during periods of high power demand indicate low voltage. Where power is supplied from more than one substation, observations should be made to determine whether there are periods when power is interrupted from a nearby station but not from a distant station or stations. This condition may be indicated by inadequate power for operating equipment and by lights connected to the power circuit becoming very dim. When these indications are observed, the cause should be determined and remedied.

Many mine explosions and mine fires will be averted and many lives saved if the industry will voluntarily take prompt measures to determine the adequacy of its electrical installations and make corrections and adjustments where necessary.

The facilities of the Bureau are available to the industry to assist in eliminating all disaster-potential and other hazards from coal mines. Mining-electrical engineers and electrical inspectors conduct special technical investigations and surveys of electrical facilities in coal mines and notify operators of hazardous or substandard conditions that are found or developing.

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These engineers are also directed to cooperate with the industry in conducting research on electrical apparatus with a view toward designing safer equipment. In addition, an electrical-safety course is available to the industry to train electricians and maintenance personnel in the fundamentals of electricity and proper installation and maintenance of electric equipment and circuits.

Furthermore, certain mines are spot-checked between regular inspections in an attempt to improve between-inspection compliance with the provisions of the Federal Mine Safety Codes and the Federal Coal Mine Safety Act. The Bureau, when notified, investigates all mine fires and gas and dust ignitions, large or small, and distributes reports thereon for the benefit of the industry to prevent recurrences.

Experience reveals that most gas explosions in coal mines could have been prevented with adequately controlled, continuous, positive ventilation, in proper volume, of all active and adjacent areas. With continuous mining, face ventilation raises a difficult problem that may have to be solved by auxiliary means. However, if no action is taken until explosive gas is detected before ventilation is improved (which, unfortunately, is still too often the general practice), disasters will be inevitable.

When the ventilating system undergoes any major revision (involving volume, pressure, or direction of air flow), it should be an established operating rule that all persons who might be affected thereby should be given explicit information. Moreover, major changes in ventilation, preferably, should be made during an idle rather than a working period, so that only those making the changeover will be in the mine or section thereof at the time.

Means of preventing coal-dust ignitions are well known to all in the industry, but adequate cleanup of loose coal and coal dust and proper application of rock dust in areas that are not wet must be prompt and continuous. Spotty, intermittent enforcement of these regulations will not suffice.

Coal mines cannot be entirely freed from fire hazards. The mineral mined is combustible; wooden timbering is used to support the roof; doors and brattices are necessary to control ventilation; rubber is employed in belts, tires, and other accessories; flammable oils and hydraulic fluids are used; and many sources of ignition are present, of which electric power is of primary importance. However, these hazards can be minimized so that there will be little danger of disastrous fires by (1) proper installation and maintenance of equipment, particularly electrical installations and belt conveyors; (2) provisions of safe, travelable, well-marked alternate escapeways; and (3) maintenance of adequate, suitable, readily available fire-fighting facilities, with employees trained in their use and familiar with their limitations.

In addition to administering the Federal Coal Mine Safety Act and conducting accident-prevention training for the mineral industries, the Bureau is continuing its program to develop methods of eliminating the major causes of mine fires and explosions. Some features of this program are: Experimental work with foam plugs to combat mine fires; publication of Schedule 28 covering the testing of conveyor belts for fire-resistant qualities; developing

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economical fire-resistant hydraulic fluids for mine equipment, incombustible thermoplastic trailing-cable insulation, and equivalent protective devices to replace grounding conductors in trailing cables; conducting intensive studies of auxiliary ventilation in continuous mining places; making electrical surveys in coal mines to determine the adequacy of electric circuits and protective devices; and initiating research to develop a monitoring device to give warning and cut off power when the methane content of the face atmosphere reaches predetermined levels.

Means of preventing mine fires and explosions are adequately covered in Federal and State laws. However, 100 percent enforcement of most safety laws is virtually impossible, unless those affected do their own policing conscientiously. Safety-education training has proved to be of inestimable value in improving safety consciousness, an absolute essential if progress is to be made. Spasmodic compliance with accepted safety practices is not enough, because each act of carelessness, thoughtlessness, or neglect of accepted safe procedures could lead to a serious accident and, under certain circumstances, to a disaster. Only unrelenting, constant vigilance by each person associated with the coal-mining industry can avert the penalties involved in gambling with the law of averages in safety.

TABLE 1. - Major disasters in coal mines, 1945-59

Calendar year	Major disasters	Persons killed	Calendar year	Major disasters	Persons killed
1945.....	5	68	1952[2].....	0	0
1946.....	2	27	1953.....	1	5
1947.....	6	179	1954.....	1	16
1948.....	6	49	1955.....	0	0
1949.....	0	0	1956.....	0	0
1950.....	0	0	1957.....	5	64
1951.....	5	157	1958.....	3	42
1952[1].....	2	11	1959.....	2	21
Total.....	26	491	Total.....	12	148

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2/ July-December only.

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TABLE 2. - Underground gas and/or dust ignitions investigated by Bureau of Mines

	1952[1/]	1953	1954	1955	1956	1957	1958	1959	Total
Alaska	0	0	0	0	0	1	0	0	1
Alabama	0	0	0	0	3	0	0	0	3
Arkansas	0	0	0	0	0	1	0	0	1
Colorado	0	0	2	0	4	1	0	1	8
Illinois	0	1	0	0	0	1	0	1	3
Indiana	0	1	2	0	7	0	0	0	10
Iowa	0	1	0	0	0	0	0	0	1
Kentucky	0	2	4	1	3	3	0	0	13
Maryland	0	0	0	1	0	0	0	0	1
Ohio	0	0	0	2	1	2	1	2	8
Oklahoma	0	0	1	0	1	0	0	0	2
Pennsylvania (anthracite)	4	11	7	9	6	7	5	3	52
Pennsylvania (bituminous)	2	5	4	3	9	6	4	4	37
Tennessee	0	0	1	0	1	0	3	1	6
Utah	0	0	0	1	1	0	0	0	2
Virginia	0	0	0	0	0	0	2	2	4
Washington	0	0	1	0	0	0	1	0	2
West Virginia	1	7	6	4	10	6	8	8	50
Total	7	28	28	21	46	28	24	22	204
Title I mines[2/]	1	7	6	6	9	2	4	2	37
Title II mines[3/]	6	21	22	15	37	26	20	20	167

1/ July-December only.
2/ Mines employing 14 or less men underground.
3/ Mines employing 15 or more men underground.

TABLE 3. - Injuries resulting from gas and/or dust ignitions

Period	Fatal	Nonfatal	Period	Fatal	Nonfatal
1952[1/]	0	13	1956	9	31
1953	14	38	1957	67	33
1954	19	44	1958	42	36
1955	4	25	1959	10	15
			Total	165	235

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TABLE 4. - Gas and/or dust ignitions by primary sources

Primary sources	1952[1/]	1953	1954	1955	1956	1957	1958	1959	Total
Electricity.....	3	10	9	8	15	11	8	8	72
Explosives.....	1	8	7	6	7	2	5	1	37
Open flame or smoking	1	7	4	3	6	8	4	2	35
Friction sparks.....	0	1	4	4	12	6	5	6	38
Safety lamp.....	0	1	0	0	0	1	2	4	8
Mine fire.....	0	0	1	0	3	0	0	0	4
Lightning.....	0	0	0	0	1	0	0	0	1
Doubtful or unknown..	2	1	3	0	2	0	0	1	9
Total.....	7	28	28	21	46	28	24	22	204

1/ July-December only.

TABLE 5. - Breakdown of electrical sources of gas and/or dust ignitions

Source of electrical ignitions	1952[1/]	1953	1954	1955	1956	1957	1958	1959	Total
Trolley locomotives or power nips.....	2	5	4	1	7	3	4	2	28
Face equipment or fans.....	0	1	3	4	3	4	2	2	19
Trailing cables.....	1	1	1	0	3	1	0	1	8
Arcs due to lack of frame grounds.....	0	1	1	3	1	2	0	3	11
Feeder cables.....	0	1	0	0	0	1	1	0	3
Switches.....	0	0	0	0	1	0	0	0	1
Light bulbs.....	0	1	0	0	0	0	0	0	1
Other stationary equipment...	0	0	0	0	0	0	1	0	1
Total.....	3	10	9	8	15	11	8	8	72

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TABLE 6. - Underground mine fires investigated by Bureau of Mines

State	1952[1/]	1953	1954	1955	1956	1957	1958	1959	Total
Alaska	0	1	1	0	0	0	1	1	4
Alabama	0	0	1	0	2	1	0	1	5
Colorado	0	0	2	0	3	3	1	1	10
Illinois	0	2	1	4	6	2	4	2	21
Indiana	0	3	3	1	1	2	3	1	14
Iowa	0	0	0	1	0	0	0	0	1
Kentucky	5	4	5	6	3	8	6	6	43
Missouri	0	0	0	0	1	0	0	0	1
New Mexico	0	0	0	0	0	0	1	0	1
Ohio	0	0	4	4	4	4	6	2	24
Oklahoma	0	0	0	3	0	0	0	0	3
Pennsylvania (anthracite)	1	3	3	2	0	7	0	4	20
Pennsylvania (bituminous)	2	6	5	11	10	9	14	4	61
Tennessee	1	2	1	1	0	1	3	2	11
Utah	2	4	3	4	2	2	0	2	19
Virginia	0	2	0	1	2	0	2	3	10
Washington	0	1	1	1	1	0	0	1	5
West Virginia	4	5	16	8	9	19	21	19	101
Wyoming	0	0	0	0	0	1	0	0	1
Total	15	33	46	47	44	59	62	49	355
Title I mines[2/]	0	6	8	6	3	8	3	2	36
Title II mines[3/]	15	27	38	41	41	51	59	47	319

1/ July-December only.
2/ Mines employing 14 or less men underground.
3/ Mines employing 15 or more men underground.

TABLE 7. - Injuries resulting from mine fires

Period	Fatal	Nonfatal	Period	Fatal	Nonfatal
1952[1/]	5	8	1956	2	5
1953	0	3	1957	2	10
1954	0	12	1958	3	18
1955	0	10	1959	0	5
			Total	12	71

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TABLE 8. - Mine fires by primary causes

Primary causes	1952[1/]	1953	1954	1955	1956	1957	1958	1959	Total
Electricity:									
Trailing cables	2	8	7	14	13	14	26	19	103
Other circuits	3	13	20	10	14	25	19	17	121
Belt friction	4	0	6	6	6	4	8	3	37
Spontaneous	2	4	5	6	5	6	4	5	37
Explosives	0	2	1	2	0	2	0	0	7
Surface fires	2	2	1	2	0	1	0	0	8
Rekindled	0	0	3	1	1	0	0	0	5
Acetylene (cutting or welding)	0	0	1	2	2	0	0	0	5
Arson	0	1	0	0	0	0	1	1	3
Doubtful or unknown	2	3	2	4	3	7	4	4	29
Total	15	33	46	47	44	59	62	49	355

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